Autonomous Navigation in GNSS-Denied Environments, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

Aurora proposes to transition UMD methods for insect-inspired, lightweight vision- and optical sensor-based navigation methods for a combined air-ground system that leverages the unique capabilities of airborne systems to achieve a progressively refined map of the exploration region which can be accessed by agents within the autonomous team for localization, and by scientists and other ground observers. Research during the Phase–I developed requirements, performed analyses and basic research that provided proof-of-concept demonstrations for navigational capabilities that will enhance the autonomous planetary and asteroid robotic exploration. Techniques derived from recent research were explored to demonstrate a concept for autonomous bio-inspired vision aided navigation to achieve navigation in GPS and magnetometer denied environments, generate obstacle maps and a 3 dimensional map of the environment based on optical flow and navigating to the origin of a map only based on optical flow input. This innovative research is providing a demonstration of the possibility of developing low size, weight and power solutions for vision based navigation by leveraging research on bio-inspired methodologies. During Phase-II further maturation of the algorithms, implementation on a higher fidelity simulation and prototypes and a conceptual design for a flight system will be pursued.

ANTICIPATED BENEFITS
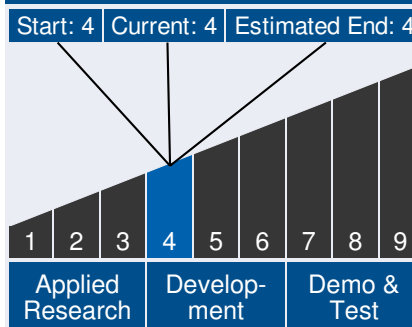
To NASA funded missions:

Potential NASA Commercial Applications: Higher return planetary exploration. The utility of a multi-vehicle air/ground system for planetary exploration is evident. The system has very broad reach, with the ability to visit and discover orders of magnitude more area than a rover. Objects of further interest can be explored by the rover, using information gathered by the air vehicles for navigation. In turn, the limited payload and endurance of the aerial exploration vehicle is mitigated by the

SPACE TECHNOLOGY

Image Not Available

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Technology Maturity

Start: 4	Current: 4	Estimated End: 4

1	2	3	4	5	6	7	8	9
Applied Research			Develop-ment			Demo & Test		

Management Team

Program Executives:
- Joseph Grant
- Laguduva Kubendran

Program Manager:
- Carlos Torrez

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ability to come back to the ground vehicle, refuel or recharge, download scientific information.

To the commercial space industry:

Potential Non-NASA Commercial Applications: The proposed system will be accepted by the community and implemented across many applications: micro and small UAVs, munitions, autonomous ground vehicles, underground mining operations and rescue, etc. The applications for DoD include urban navigation in GPS-denied scenarios and border patrol and intelligence gathering for navigation inside buildings and caves.

U.S. WORK LOCATIONS AND KEY PARTNERS
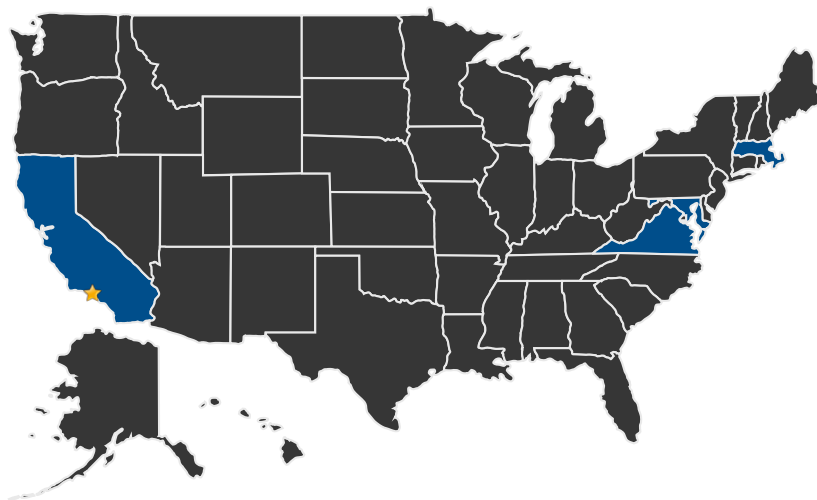
■ U.S. States With Work
★ **Lead Center:** Jet Propulsion Laboratory

Other Organizations Performing Work:

- Aurora Flight Sciences Corporation (Manassas, VA)
- University of Maryland (College Park, MD)

Management Team *(cont.)*

Project Manager:
- Bonnie Allen

Principal Investigator:
- Terrence McKenna

Technology Areas

Primary Technology Area:
Robotics and Autonomous Systems (TA 4)
└ Sensing and Perception (TA 4.1)
  └ State Estimation (TA 4.1.2)
    └ Map-Based Position Estimation for Navigation of Surface Vehicles (TA 4.1.2.2)

Secondary Technology Area:
Communications, Navigation, and Orbital Debris Tracking and Characterization Systems (TA 5)
└ Position, Navigation, and Timing (TA 5.4)
  └ Sensors and Vision Processing Systems (TA 5.4.3)

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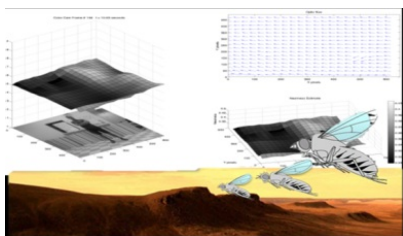SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23063)

IMAGE GALLERY

Autonomous Navigation in GNSS-Denied Environments, Phase II

DETAILS FOR TECHNOLOGY 1

Technology Title

Autonomous Navigation in GNSS-Denied Environments

Potential Applications

Higher return planetary exploration. The utility of a multi-vehicle air/ground system for planetary exploration is evident. The system has very broad reach, with the ability to visit and discover orders of magnitude more area than a rover. Objects of further interest can be explored by the rover, using information gathered by the air vehicles for navigation. In turn, the limited payload and endurance of the aerial exploration vehicle is mitigated by the ability to come back to the ground vehicle, refuel or recharge, download scientific information.